

What is Claimed is:

- 1 1. A composition adapted for selective removal of tantalum in chemical mechanical
2 polishing, comprising:
3 at least one reducing agent;
4 ions from at least one transitional metal; and
5 water.
- 1 2. The composition of claim 1, further comprising at least one pH adjusting agent.
- 1 3. The composition of claim 1, wherein the concentration of the at least one reducing
2 agent is at least about 0.005 weight percent.
- 1 4. The composition of claim 1, wherein the reducing agent is selected from the group
2 consisting of hydroxylamine, glucose, sulfothionate, potassium iodide, sodium thiosulfate,
3 oxalic acid, or combinations thereof. A
- 1 5. The composition of claim 1, wherein the composition has an initial pH in the range
2 in which the at least one reducing agent is active.
- 1 6. The composition of claim 1, wherein the composition has an initial pH between
2 about 2 and about 12.
- 1 7. The composition of claim 6, wherein the reducing agent comprises hydroxylamine
2 and the initial pH is between about 3 and about 11.
- 1 8. The composition of claim 6, wherein the reducing agent comprises glucose and the
2 initial pH is between about 8 and about 12.
- 1 9. The composition of claim 6, wherein the reducing agent comprises sulfothionate
2 and the initial pH is between about 3 and about 11.
- 1 10. The composition of claim 6, wherein the reducing agent comprises potassium
2 iodide and the initial pH is between about 3 and about 11.

1 11. The composition of claim 6, wherein the reducing agent comprises sodium
2 thiosulfate and the initial pH is between about 3 and about 11.

1 12. The composition of claim 6, wherein the reducing agent comprises oxalic acid and
2 the initial pH is between about 4.5 and about 5.5.

1 13. The composition of claim 1, further comprising at least one corrosion inhibitor.

1 14. The composition of claim 13, wherein the concentration of the corrosion inhibitor
2 is up to about 2 weight percent.

1 15. The composition of claim 13, wherein the corrosion inhibitor comprises an organic
2 compound comprising at least one azole group.

1 16. The composition of claim 15, wherein the corrosion inhibitor is selected from the
2 group consisting of benzotriazole, mercaptobenzotriazole, 5-methyl-1-benzotriazole, or
3 combinations thereof.

1 17. The composition of claim 1, further comprising at least one buffer.

1 18. The composition of claim 17, wherein concentration of the buffer is from about 0.1
2 to about 8 weight percent.

1 19. The composition of claim 17, wherein the buffer is selected from the group
2 consisting of metal bicarbonate, tetraborate tetrahydrate salts, or combinations thereof.

1 20. The composition of claim 1, further comprising abrasive particles.

1 21. The composition of claim 1, further comprising abrasive particles in a
2 concentration of from about 0 weight percent to about 1 weight percent.

1 22. The composition of claim 1, wherein the ions from the at least one transitional
2 metal are selected from the group consisting of copper ions, iron ions, or combinations
3 thereof.

1 23. The composition of claim 1, wherein the ions from the at least one transitional
2 metal are provided in a high valence state.

1 24. The composition of claim 1, wherein the ions from the at least one transitional
2 metal are generated in situ during polishing.

1 25. The composition of claim 1, wherein the ions from the at least one transitional
2 metal are provided in an aqueous solution.

1 26. The composition of claim 1, wherein the ions from the at least one transitional
2 metal are provided by contacting sold metal to a polishing pad.

1 27. A method for selective removal of a tantalum layer from a substrate in chemical
2 mechanical polishing, comprising:
3 applying a composition to a polishing pad, the composition comprising:
4 at least one reducing agent;
5 ions from at least one transitional metal; and
6 water, and
7 polishing the substrate in presence of the composition to remove the tantalum
8 layer.

1 28. The method of claim 27, wherein the composition further comprises at least one
2 pH adjusting agent.

1 29. The method of claim 27, wherein the concentration of the at least one reducing
2 agent is at least 0.005 weight percent.

1 30. The method of claim 27, wherein the reducing agent is selected from the group
2 consisting of hydroxylamine, glucose, sulfothionate, potassium iodide, sodium thiosulfate,
3 oxalic acid, or combinations thereof.

1 31. The method of claim 27, wherein the composition has an initial pH in the range in
2 which the at least one reducing agent is active.

1 32. The method of claim 27, wherein the composition has an initial pH between about
2 2 and about 12.

1 33. The method of claim 32, wherein the reducing agent comprises hydroxylamine and
2 the initial pH is between about 3 and about 11.

1 34. The method of claim 32, wherein the reducing agent comprises glucose and the
2 initial pH is between about 8 and about 12.

1 35. The method of claim 32, wherein the reducing agent comprises sulfothionate and
2 the initial pH is between about 3 and about 11.

1 36. The method of claim 32, wherein the reducing agent comprises potassium iodide
2 and the initial pH is between about 3 and about 11.

1 37. The method of claim 32, wherein the reducing agent comprises sodium thiosulfate
2 and the initial pH is between about 3 and about 11.

1 38. The method of claim 32, wherein the reducing agent comprises oxalic acid and the
2 initial pH is between about 4.5 and about 5.5.

1 39. The method of claim 27, wherein the composition further comprises at least one
2 corrosion inhibitor.

1 40. The method of claim 39, wherein the concentration of the corrosion inhibitor is up
2 to about 2 weight percent.

1 41. The method of claim 39, wherein the corrosion inhibitor comprises an organic
2 compound comprising at least one azole group.

1 42. The method of claim 41, wherein the corrosion inhibitor is selected from the group
2 consisting of benzotriazole, mercaptobenzotriazole, 5-methyl-1-benzotriazole, or
3 combinations thereof.

1 43. The method of claim 27, further comprising at least one buffer.

1 44. The method of claim 43, wherein concentration of the buffer is from about 0.1 to
2 about 8 weight percent.

1 45. The method of claim 43, wherein the buffer is selected from the group consisting
2 of metal bicarbonate, tetraborate tetrahydrate salts, or combinations thereof.

1 46. The method of claim 27, wherein the composition further comprises abrasive
2 particles.

1 47. The method of claim 27, further comprising abrasive particles in a concentration of
2 from about 0 weight percent to about 10 weight percent.

1 48. The method of claim 27, wherein the ions from the at least one transitional metal
2 are generated in situ during polishing.

1 49. The method of claim 27, wherein the ions from the at least one transitional metal
2 are provided in an aqueous solution.

1 50. The method of claim 27, wherein the ions from the at least one transitional metal
2 are provided by contacting solid metal to a polishing pad.

1 51. The method of claim 27, wherein the ions from the at least one transitional metal
2 are selected from the group consisting of copper ions, iron ions, or combinations thereof.

1 52. The method of claim 27, wherein the ions from the at least one transitional metal
2 are provided in a high valence state.

1 53. The method of claim 27, wherein during polishing of the substrate the tantalum
2 layer is removed from the substrate at a ratio of tantalum layer to conductive material
3 layer to dielectric layer between about 1:0:0 to about 1:0.2:0.2.

1 54. The method of claim 27, wherein during polishing of the substrate the tantalum
2 layer is removed from the substrate at a rate of at least about 250 Å/min.

1 55. A method for planarizing a substrate having a conductive material layer and a
2 barrier layer deposited thereon, comprising:
3 applying a conductive-material-layer-selective composition to a polishing pad;
4 polishing the substrate in presence of the conductive-material-layer-selective
5 composition;
6 applying a barrier-layer-selective composition to a polishing pad, the barrier-layer-
7 selective composition comprising:
8 at least one reducing agent;
9 ions from at least one transitional metal; and
10 water, and
11 polishing the substrate in presence of the barrier-layer-selective composition.

1 56. The method of claim 55, wherein the conductive-material-layer-selective
2 composition comprises:
3 at least one chelating agent;
4 at least one oxidizer;
5 at least one corrosion inhibitor; and
6 water.

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1 57. The method of claim 56, wherein the conductive-material-layer-selective
2 composition further comprises at least one pH adjusting agent.

1 58. The method of claim 56, wherein the conductive-material-layer-selective
2 composition further comprises abrasive particles.

1 59. The method of claim 55, wherein during polishing the substrate in presence of the
2 conductive-material-layer-selective composition, the conductive material layer is removed
3 from the substrate at a ratio of conductive material layer to barrier layer between about
4 1:0.0 to about 1:0.1.

1 60. The method of claim 55, wherein the barrier-layer-selective composition further
2 comprises at least one pH adjusting agent.

1 61. The method of claim 55, wherein the barrier-layer-selective composition further
2 comprises at least one corrosion inhibitor.

1 62. The method of claim 55, wherein the barrier-layer selective composition further
2 comprises at least one buffer.

1 63. The method of claim 55, wherein the barrier-layer-selective composition further
2 comprises abrasive particles.

1 64. The method of claim 55, wherein the barrier-layer-selective composition further
2 comprising abrasive particles in a concentration of from about 0 weight percent to about
3 10 weight percent.

1 65. The method of claim 55, wherein during polishing the substrate in presence of the
2 barrier-layer-selective composition the barrier layer is removed from the substrate at a
3 ratio of barrier layer to conductive material layer to dielectric layer between about 1:0:0 to
4 about 1:0.2:0.2.

1 66. The method of claim 55, wherein during polishing the substrate in presence of the
2 barrier-layer-selective composition the barrier layer is removed from the substrate at a rate
3 of at least about 250 Å/min.

1 67. A method for processing a substrate, comprising:
2 providing a substrate comprising a dielectric layer with feature definitions formed
3 therein, a barrier layer conformally deposited on the dielectric layer and in the feature
4 definitions formed therein, and a conductive material layer deposited on the barrier layer
5 and filling the feature definitions formed therein;
6 polishing the substrate with a composition comprising a chelating agent, an
7 oxidizer, a corrosion inhibitor, and water to remove the conductive material layer; and
8 polishing the substrate with a composition comprising at least one reducing agent,
9 and water to remove the barrier layer.